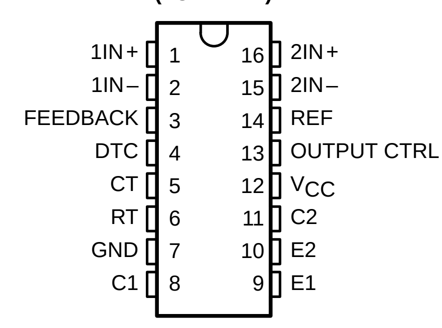
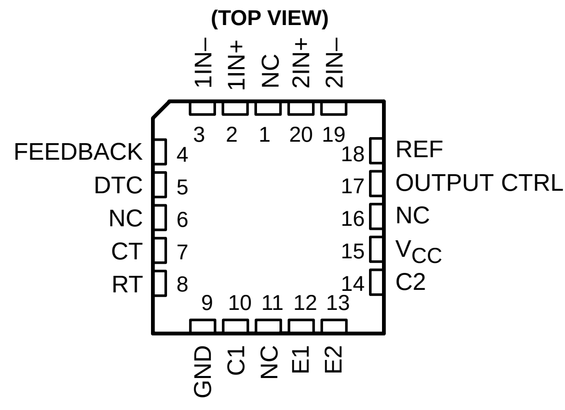
- **Complete PWM Power Control Circuitry**
- **Uncommitted Outputs for 200-mA Sink or Source Current**
- **Output Control Selects Single-Ended or Push-Pull Operation**
- **Internal Circuitry Prohibits Double Pulse at Either Output**
- **Variable Dead Time Provides Control Over Total Range**
- **Internal Regulator Provides a Stable 5-V Reference Supply With 5% Tolerance**
- **Circuit Architecture Allows Easy Synchronization**

TL494C, TL494I . . . D, N, OR PW PACKAGE
TL494M . . . J PACKAGE
(TOP VIEW)



TL494M . . . FK PACKAGE
(TOP VIEW)



NC – No internal connection

description

The TL494 incorporates on a single monolithic chip all the functions required in the construction of a pulse-width-modulation control circuit. Designed primarily for power supply control, this device offers the systems engineer the flexibility to tailor the power supply control circuitry to a specific application.

The TL494 contains two error amplifiers, an on-chip adjustable oscillator, a dead-time control (DTC) comparator, a pulse-steering control flip-flop, a 5-V, 5%-precision regulator, and output-control circuits.

The error amplifiers exhibit a common-mode voltage range from –0.3 V to V_{CC} –2 V. The dead-time control comparator has a fixed offset that provides approximately 5% dead time. The on-chip oscillator may be bypassed by terminating RT to the reference output and providing a sawtooth input to CT, or it may drive the common circuits in synchronous multiple-rail power supplies.

FUNCTION TABLE

INPUT TO OUTPUT CTRL	OUTPUT FUNCTION
V_I = GND	Single-ended or parallel output
V_I = V_{ref}	Normal push-pull operation

AVAILABLE OPTIONS

T_A	PACKAGED DEVICES					CHIP FORM (Y)
	SURFACE MOUNT (D)†	CHIP CARRIER (FK)	CERAMIC DIP (J)	PLASTIC DIP (N)	SHRINK SMALL OUTLINE (PW)‡	
0°C to 70°C	TL494CD	—	—	TL494CN	TL494CPW	TL494Y
–40°C to 85°C	TL494ID	—	—	TL494IN	—	—
–55°C to 125°C	—	TL494MFK	TL494MJ	—	—	—

† The D package is available taped and reeled. Add R suffix to device type (e.g., TL494CDR).
‡ The PW package is only available left-end taped and reeled.

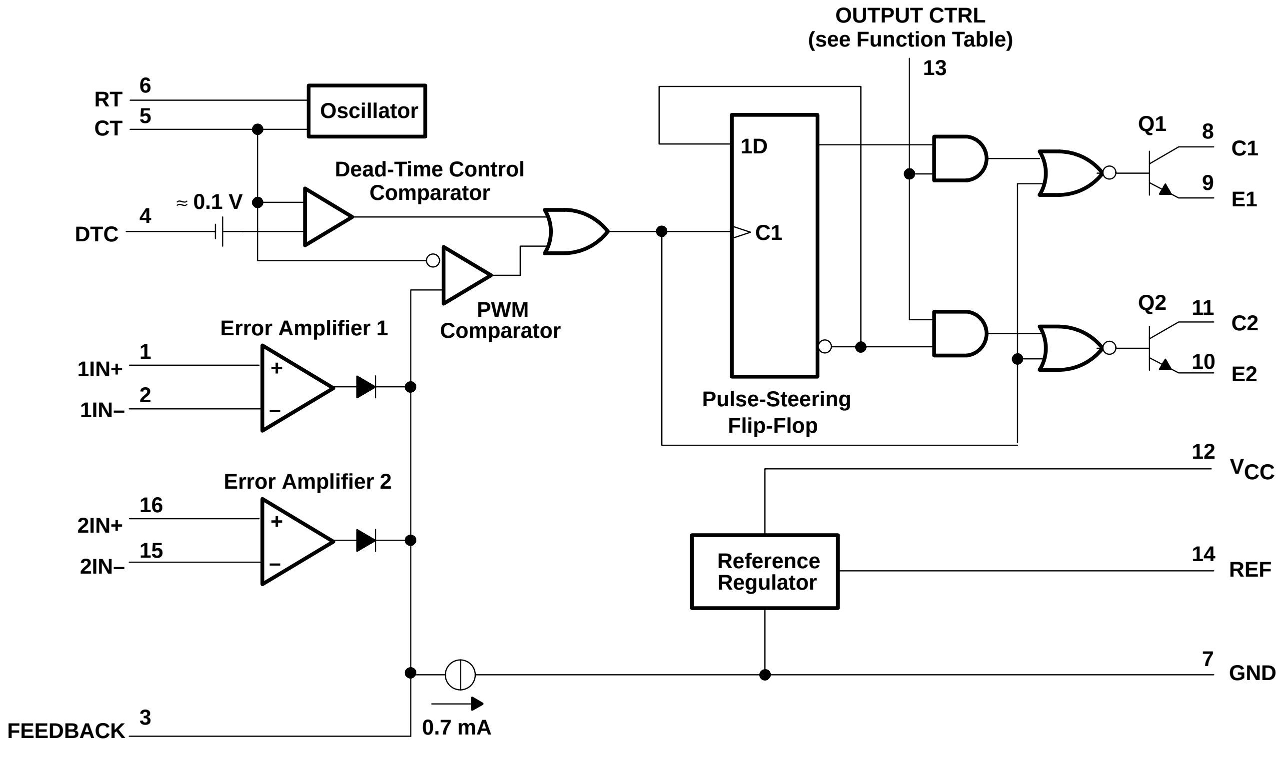


description (continued)

The uncommitted output transistors provide either common-emitter or emitter-follower output capability. The TL494 provides for push-pull or single-ended output operation, which may be selected through the output-control function. The architecture of this device prohibits the possibility of either output being pulsed twice during push-pull operation.

The TL494C is characterized for operation from 0°C to 70°C. The TL494I is characterized for operation from –40°C to 85°C. The TL494M is characterized for operation from –55°C to 125°C.

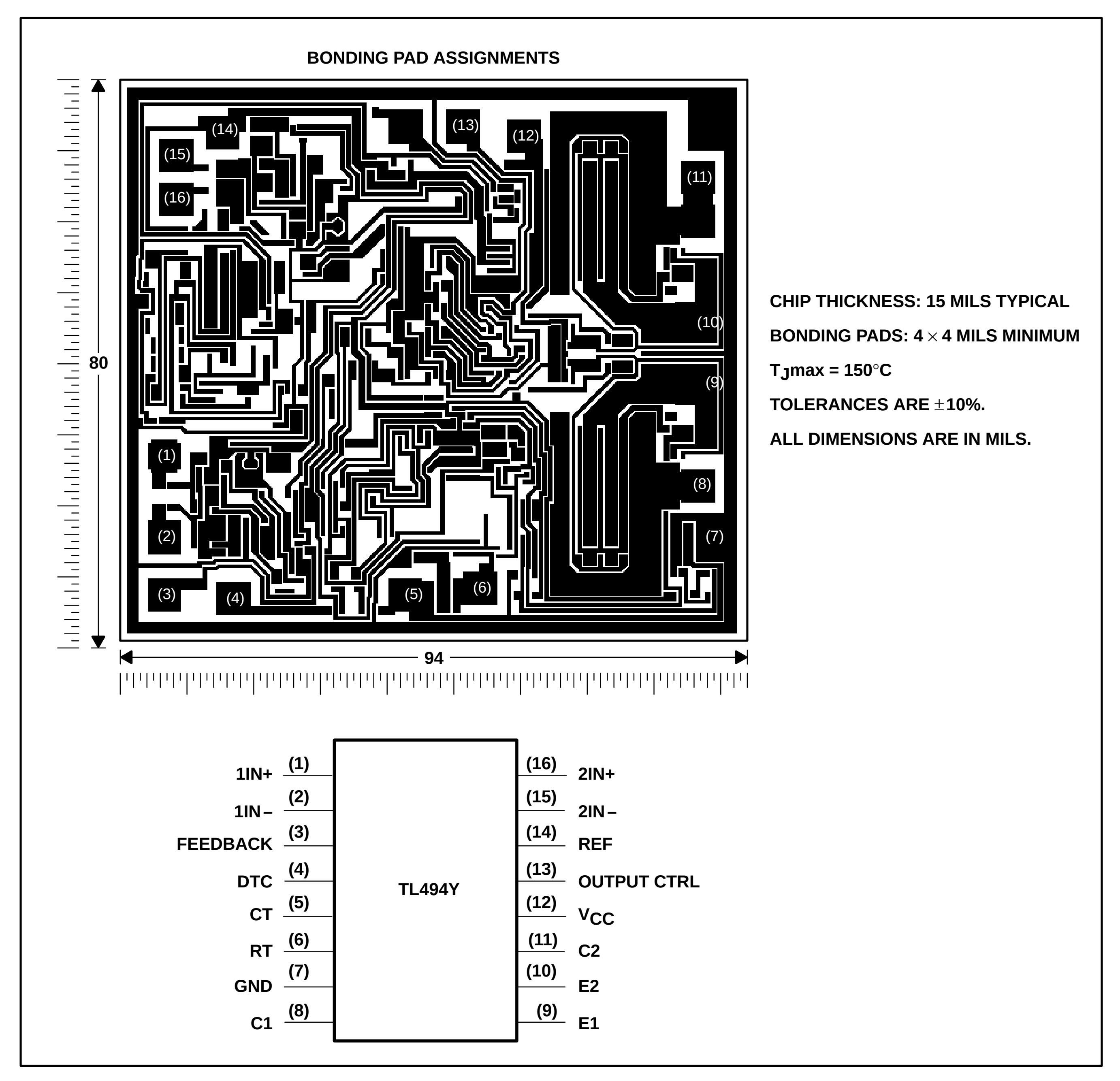
functional block diagram



NOTE A. The terminal numbers indicated apply only to the D, J, N, and PW packages.

TL494Y chip information

This chip, when properly assembled, display characteristics similar to the TL494C. Thermal compression or ultrasonic bonding may be used on the doped aluminum bonding pads. The chips may be mounted with conductive epoxy or a gold-silicon preform.



absolute maximum ratings over operating free-air temperature range (unless otherwise noted)†

	TL494C	TL494I	TL494M	UNIT
Supply voltage, V_{CC} (see Note 1)	41	41	41	V
Amplifier input voltage, V_I	V_{CC} + 0.3	V_{CC} + 0.3	V_{CC} + 0.3	V
Collector output voltage, V_O	41	41	41	V
Collector output current, I_O	250	250	250	mA
Continuous total power dissipation	See Dissipation Rating Table			
Operating free-air temperature range, T_A	0 to 70	–40 to 85	–55 to 125	°C
Storage temperature range, T_{stg}	–65 to 150	–65 to 150	–65 to 150	°C
Case temperature for 60 seconds, T_C: FK package	—	—	260	°C
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds: D, N, or PW package	260	260	—	°C
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds: J package	—	—	300	°C

† Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

NOTE 1: All voltage values, except differential voltages, are with respect to the network ground terminal.

DISSIPATION RATING TABLE

PACKAGE	$T_A \leq 25°C$ POWER RATING	DERATING FACTOR	DERATE ABOVE T_A	$T_A = 70°C$ POWER RATING	$T_A = 85°C$ POWER RATING	$T_A = 125°C$ POWER RATING
D	900 mW	7.6 mW/°C	25°C	558 mW	444 mW	—
FK	1375 mW	11.0 mW/°C	25°C	880 mW	715 mW	275 mW
J	1375 mW	11.0 mW/°C	25°C	880 mW	715 mW	275 mW
N	1000 mW	9.2 mW/°C	41°C	733 mW	595 mW	—
PW	700 mW	5.6 mW/°C	25°C	448 mW	—	—

recommended operating conditions

	TL494C		TL494I		TL494M		UNIT
	MIN	MAX	MIN	MAX	MIN	MAX	
Supply voltage, V_{CC}	7	40	7	40	7	40	V
Amplifier input voltage, V_I	–0.3	V_{CC}–2	–0.3	V_{CC}–2	–0.3	V_{CC}–2	V
Collector output voltage, V_O		40		40		40	V
Collector output current (each transistor)		200		200		200	mA
Current into feedback terminal		0.3		0.3		0.3	mA
Oscillator frequency, f_{osc}	1	300	1	300	1	300	kHz
Timing capacitor, C_T	0.47	10 000	0.47	10 000	0.47	10 000	nF
Timing resistor, R_T	1.8	500	1.8	500	1.8	500	kΩ
Operating free-air temperature, T_A	0	70	–40	85	–55	125	°C

electrical characteristics over recommended operating free-air temperature range, V_{CC} = 15 V, f = 10 kHz (unless otherwise noted)

reference section

PARAMETER	TEST CONDITIONS†	TL494C, TL494I			TL494M			UNIT
		MIN	TYP‡	MAX	MIN	TYP‡	MAX	
Output voltage (REF)	I_O = 1 mA	4.75	5	5.25	4.75	5	5.25	V
Input regulation	V_{CC} = 7 V to 40 V		2	25		2	25	mV
Output regulation	I_O = 1 mA to 10 mA		1	15		1	15	mV
Output voltage change with temperature	ΔT_A = MIN to MAX		2	10		2	30*	mV/V
Short-circuit output current§	REF = 0 V		25			–25		mA

* On products compliant to MIL-STD-883, Class B, this parameter is not production tested.
† For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.
‡ All typical values except for parameter changes with temperature are at T_A = 25°C.
§ Duration of the short circuit should not exceed one second.

oscillator section, C_T = 0.01 μF, R_T = 12 kΩ (see Figure 1)

PARAMETER	TEST CONDITIONS†	TL494C, TL494I			TL494M			UNIT
		MIN	TYP‡	MAX	MIN	TYP‡	MAX	
Frequency			10			10		kHz
Standard deviation of frequency¶	All values of V_{CC}, CT, RT, and T_A constant		100			100		Hz/kHz
Frequency change with voltage	V_{CC} = 7 V to 40 V, T_A = 25°C		1			1		Hz/kHz
Frequency change with temperature#	ΔT_A = MIN to MAX			10			10*	Hz/kHz

* On products compliant to MIL-STD-883, Class B, this parameter is not production tested.
† For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.
‡ All typical values except for parameter changes with temperature are at T_A = 25°C.
¶ Standard deviation is a measure of the statistical distribution about the mean as derived from the formula:
Temperature coefficient of timing capacitor and timing resistor not taken into account.

$$\sigma = \sqrt{\frac{\sum_{n=1}^{N} (x_n - \overline{X})^2}{N - 1}}$$

error amplifier section (see Figure 2)

PARAMETER	TEST CONDITIONS	TL494C, TL494I TL494M			UNIT
		MIN	TYP‡	MAX	
Input offset voltage	V_O (FEEDBACK) = 2.5 V		2	10	mV
Input offset current	V_O (FEEDBACK) = 2.5 V		25	250	nA
Input bias current	V_O (FEEDBACK) = 2.5 V		0.2	1	μA
Common-mode input voltage range	V_{CC} = 7 V to 40 V	–0.3 to V_{CC}–2			V
Open-loop voltage amplification	ΔV_O = 3 V, R_L = 2 kΩ, V_O = 0.5 V to 3.5 V	70	95		dB
Unity-gain bandwidth	V_O = 0.5 V to 3.5 V, R_L = 2 kΩ		800		kHz
Common-mode rejection ratio	ΔV_O = 40 V, T_A = 25°C	65	80		dB
Output sink current (FEEDBACK)	V_{ID} = –15 mV to –5 V, V (FEEDBACK) = 0.7 V	0.3	0.7		mA
Output source current (FEEDBACK)	V_{ID} = 15 mV to 5 V, V (FEEDBACK) = 3.5 V	–2			mA

‡ All typical values except for parameter changes with temperature are at T_A = 25°C.

electrical characteristics over recommended operating free-air temperature range, V_{CC} = 15 V, f = 10 kHz, T_A = 25°C (unless otherwise noted)

reference section

PARAMETER	TEST CONDITIONS	TL494Y			UNIT
		MIN	TYP†	MAX	
Output voltage (REF)	I_O = 1 mA		5		V
Input regulation	V_{CC} = 7 V to 40 V		2		mV
Output regulation	I_O = 1 mA to 10 mA		1		mV
Short-circuit output current‡	REF = 0 V		25		mA

oscillator section, C_T = 0.01 μF, R_T = 12 kΩ (see Figure 1)

PARAMETER	TEST CONDITIONS	TL494Y			UNIT
		MIN	TYP†	MAX	
Frequency			10		kHz
Standard deviation of frequency§	All values of V_{CC}, CT, RT, and T_A constant		100		Hz/kHz
Frequency change with voltage	V_{CC} = 7 V to 40 V, T_A = 25°C		1		Hz/kHz

error amplifier section (see Figure 2)

PARAMETER	TEST CONDITIONS	TL494Y			UNIT
		MIN	TYP†	MAX	
Input offset voltage	V_O (FEEDBACK) = 2.5 V		2		mV
Input offset current	V_O (FEEDBACK) = 2.5 V		25		nA
Input bias current	V_O (FEEDBACK) = 2.5 V		0.2		μA
Open-loop voltage amplification	ΔV_O = 3 V, R_L = 2 kΩ, V_O = 0.5 V to 3.5 V		95		dB
Unity-gain bandwidth	V_O = 0.5 V to 3.5 V, R_L = 2 kΩ		800		kHz
Common-mode rejection ratio	ΔV_O = 40 V, T_A = 25°C		80		dB
Output sink current (FEEDBACK)	V_{ID} = –15 mV to – 5 V, V (FEEDBACK) = 0.7 V		0.7		mA

† All typical values except for parameter changes with temperature are at T_A = 25°C.
‡ Duration of the short circuit should not exceed one second.
§ Standard deviation is a measure of the statistical distribution about the mean as derived from the formula:

$$\sigma = \sqrt{\frac{\sum_{n=1}^{N} (x_n - \overline{X})^2}{N - 1}}$$

electrical characteristics over recommended operating free-air temperature range, V_{CC} = 15 V, f = 10 kHz (unless otherwise noted)

output section

PARAMETER		TEST CONDITIONS		TL494C, TL494I TL494M, TL494Y MIN	TYP†	MAX	UNIT
Collector off-state current		V_{CE} = 40 V,	V_{CC} = 40 V		2	100	μA
Emitter off-state current		V_{CC} = V_C = 40 V,	V_E = 0			–100	μA
Collector-emitter saturation voltage	Common emitter	V_E = 0,	I_C = 200 mA		1.1	1.3	V
	Emitter follower	$V_{O(C1\ or\ C2)}$ = 15 V,	I_E = –200 mA		1.5	2.5	
Output control input current		V_I = V_{ref}				3.5	mA

† All typical values except for temperature coefficient are at T_A = 25°C.

dead-time control section (see Figure 1)

PARAMETER	TEST CONDITIONS	TL494C, TL494I TL494Y			TL494M			UNIT
		MIN	TYP†	MAX	MIN	TYP†	MAX	
Input bias current (DEAD-TIME CTRL)	V_I = 0 to 5.25 V		–2	–10		–2	–10	μA
Maximum duty cycle, each output	V_I (DEAD-TIME CTRL) = 0, C_T = 0.1 μF, R_T = 12 kΩ		45%			45%	50%*	
Input threshold voltage (DEAD-TIME CTRL)	Zero duty cycle		3	3.3		3	3.3	V
	Maximum duty cycle	0			0*			

* On products compliant to MIL-STD-883, Class B, this parameter is not production tested.
† All typical values except for temperature coefficient are at T_A = 25°C.

PWM comparator section (see Figure 1)

PARAMETER	TEST CONDITIONS	TL494C, TL494I TL494M, TL494Y MIN	TYP†	MAX	UNIT
Input threshold voltage (FEEDBACK)	Zero duty cycle		4	4.5	V
Input sink current (FEEDBACK)	V (FEEDBACK) = 0.7 V	0.3	0.7		mA

† All typical values except for temperature coefficient are at T_A = 25°C.

total device

PARAMETER	TEST CONDITIONS		TL494C, TL494I TL494Y			TL494M			UNIT
			MIN	TYP†	MAX	MIN	TYP†	MAX	
Standby supply current	RT = V_{ref}, All other inputs and outputs open	V_{CC} = 15 V		6	10		6	21	mA
		V_{CC} = 40 V		9	15		9	26	
Average supply current	V_I (DEAD-TIME CTRL) = 2 V,	See Figure 1		7.5			7.5		mA

† All typical values except for temperature coefficient are at T_A = 25°C.

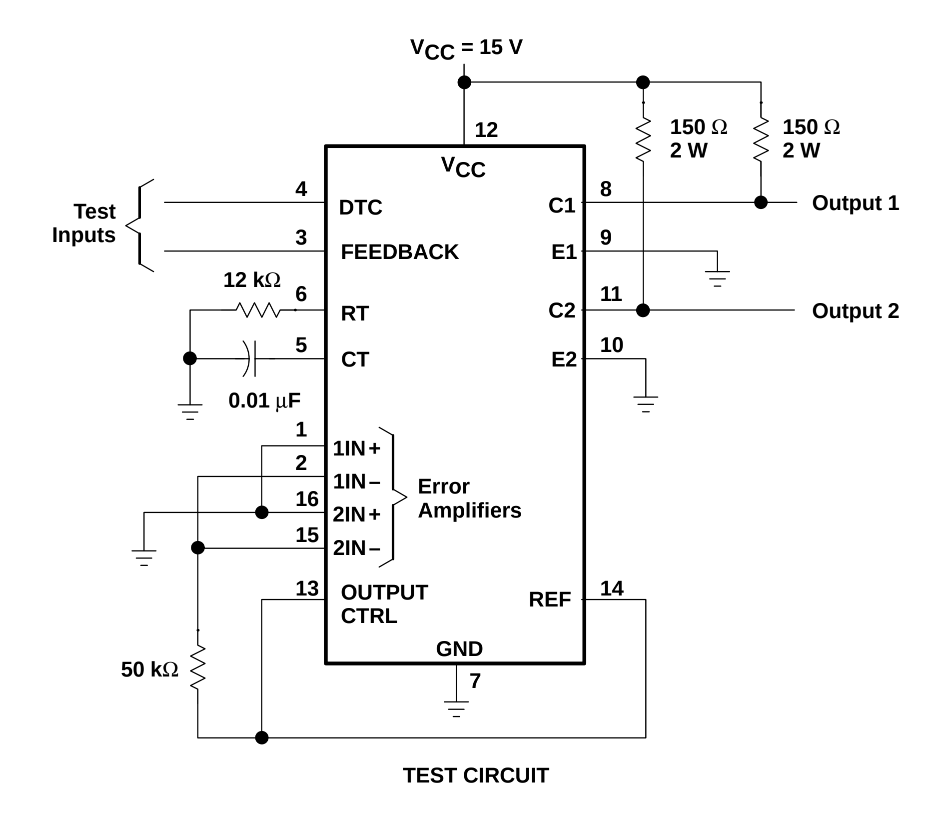
electrical characteristics over recommended operating free-air temperature range, V_{CC} = 15 V, f = 10 kHz (unless otherwise noted) (continued)

switching characteristics, T_A = 25°C

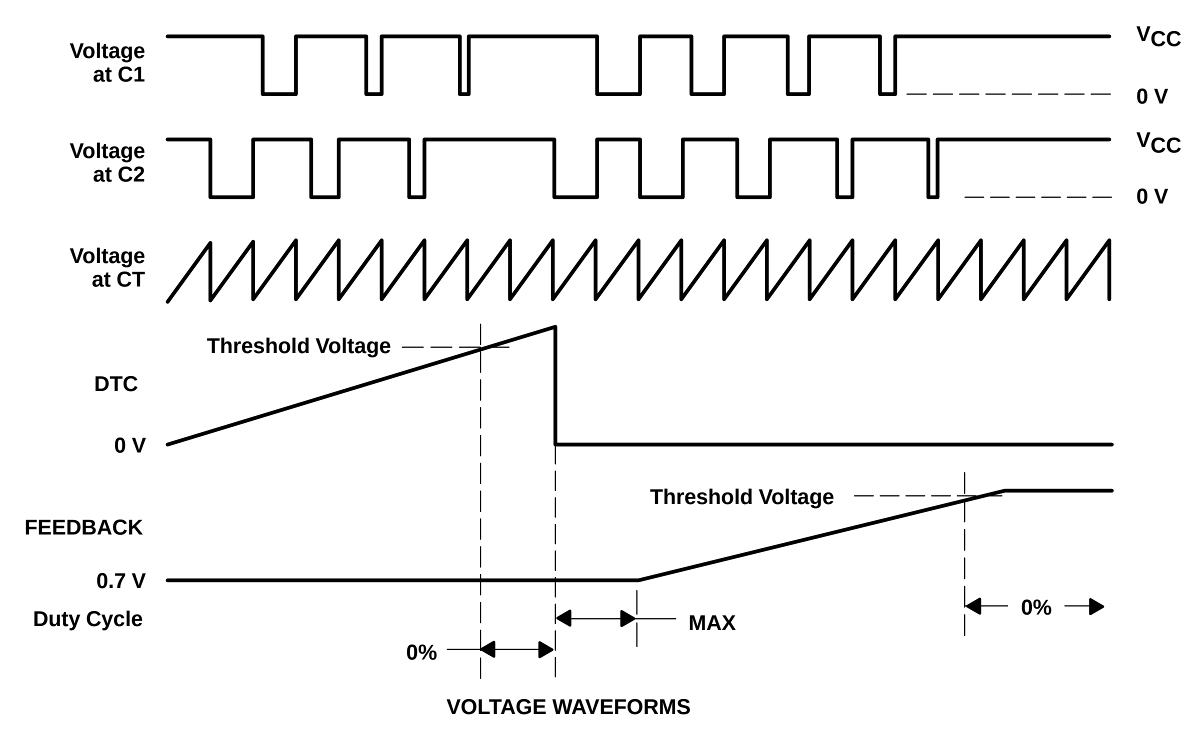
PARAMETER	TEST CONDITIONS		TL494C, TL494I TL494Y			TL494M			UNIT
			MIN	TYP†	MAX	MIN	TYP†	MAX	
Rise time	Common-emitter configuration,	See Figure 3		100	200		100	200*	ns
Fall time	Common-emitter configuration,	See Figure 3		25	100		25	100*	ns
Rise time	Emitter-follower configuration,	See Figure 4		100	200		100	200*	ns
Fall time	Emitter-follower configuration,	See Figure 4		40	100		40	100*	ns

* On products compliant to MIL-STD-883, Class B, this parameter is not production tested.
† All typical values except for temperature coefficient are at T_A = 25°C.

PARAMETER MEASUREMENT INFORMATION



TEST CIRCUIT



VOLTAGE WAVEFORMS

Figure 1. Operational Test Circuit and Waveforms

PARAMETER MEASUREMENT INFORMATION

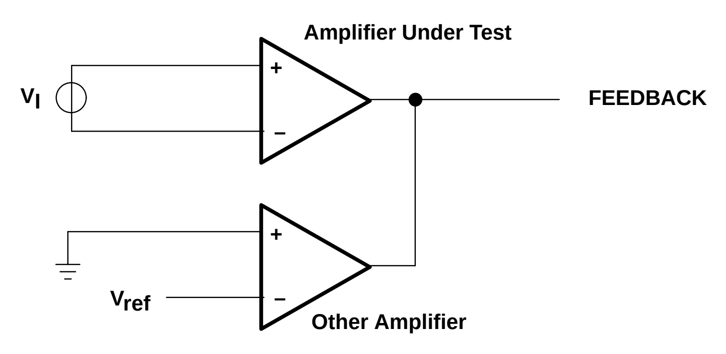
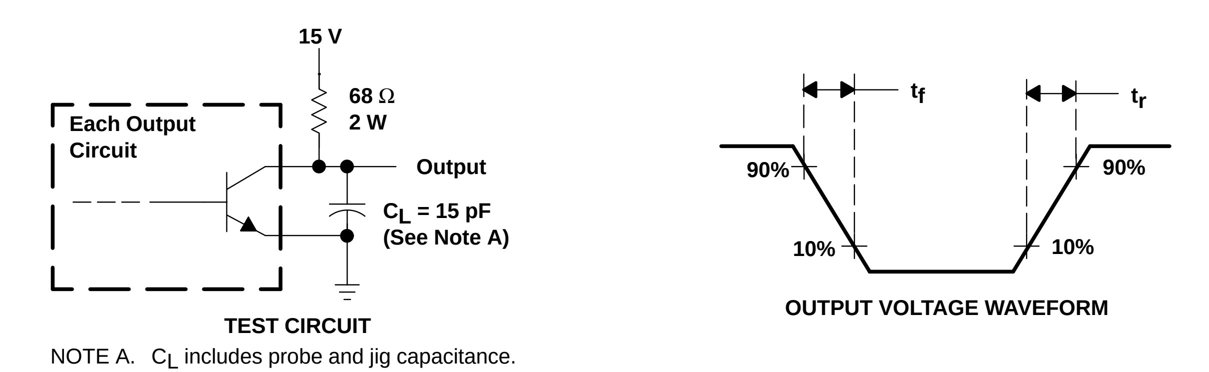
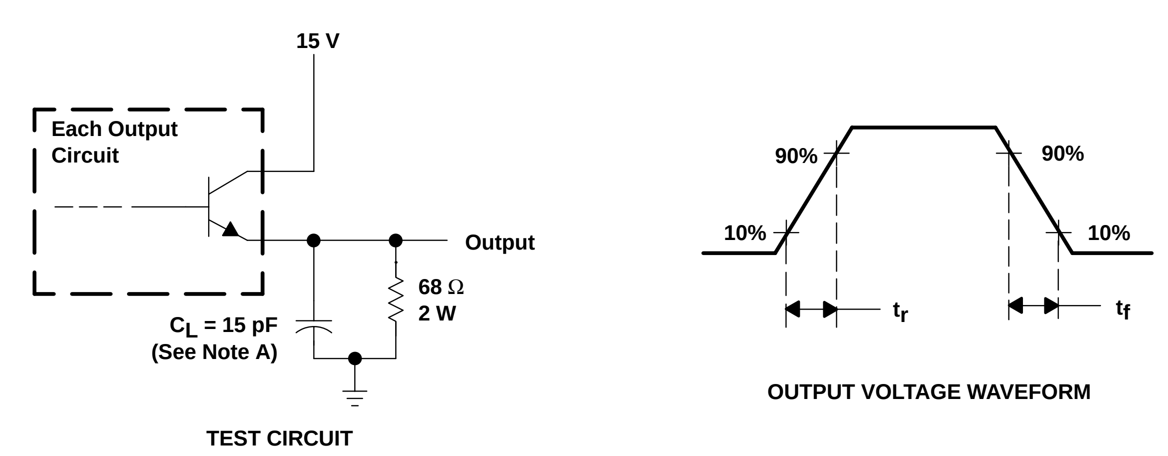


Figure 2. Amplifier Characteristics



NOTE A. C_L includes probe and jig capacitance.

Figure 3. Common-Emitter Configuration



NOTE A. C_L includes probe and jig capacitance.

Figure 4. Emitter-Follower Configuration

TYPICAL CHARACTERISTICS

OSCILLATOR FREQUENCY AND FREQUENCY VARIATION† vs TIMING RESISTANCE



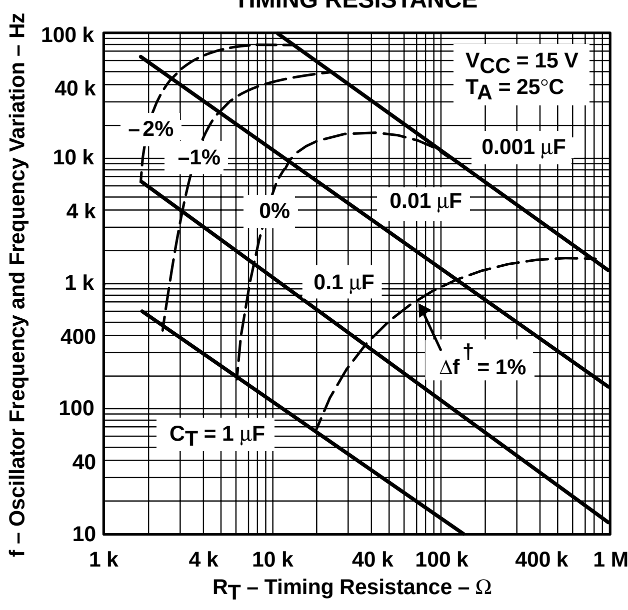


Figure 5

† Frequency variation (Δf) is the change in oscillator frequency that occurs over the full temperature range.

AMPLIFIER VOLTAGE AMPLIFICATION vs FREQUENCY

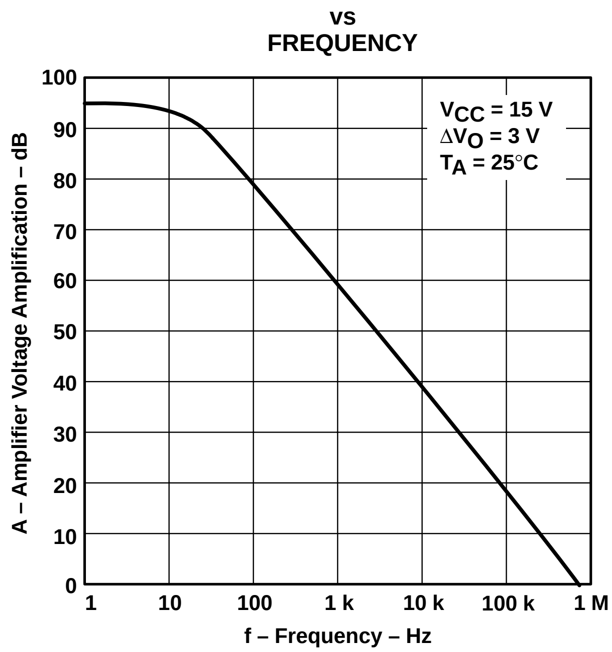


Figure 6